per Dave Radomski received 12/13/07

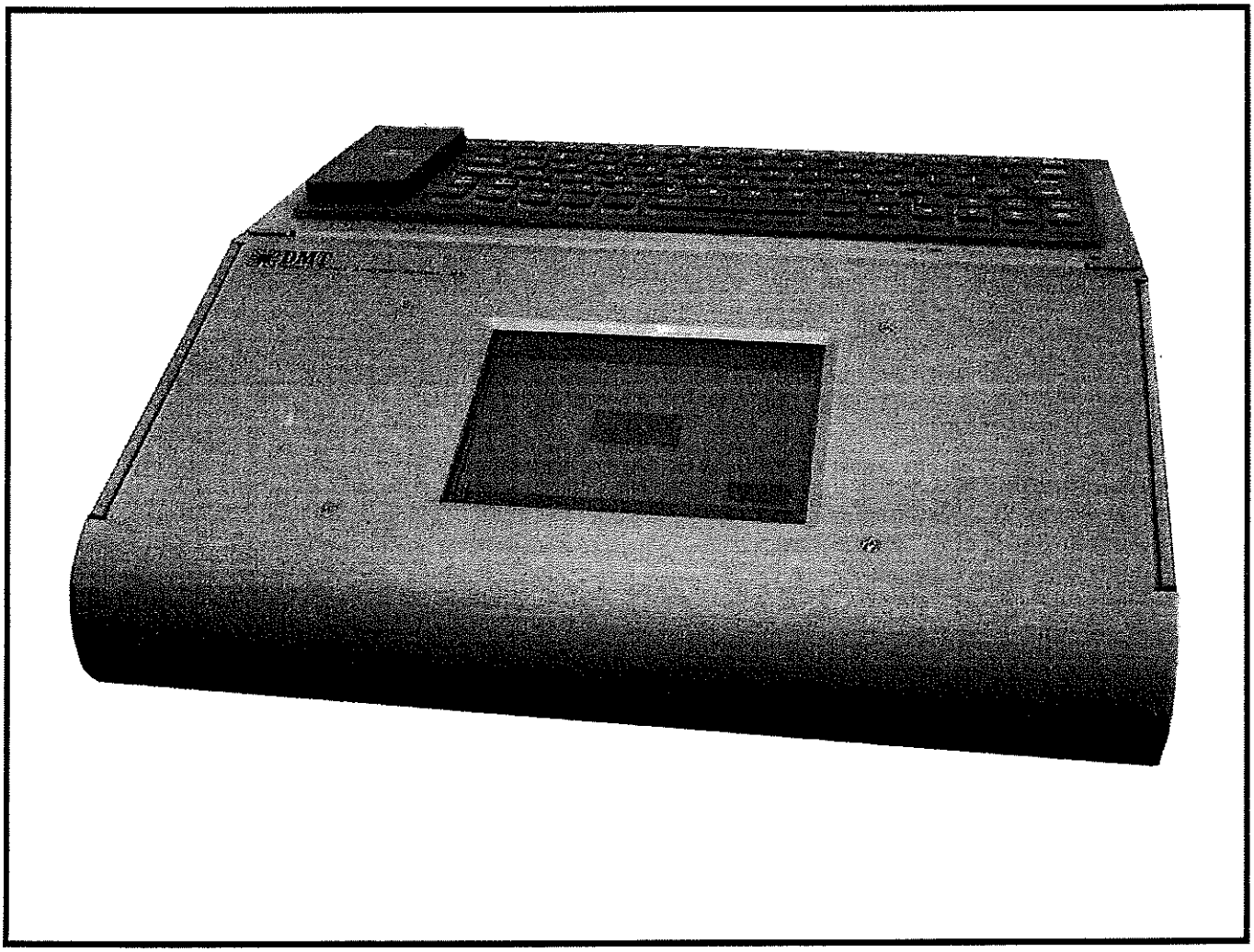
DRAFT

DataMaster™

Infrared Alcohol Breath Test Instruments

by...

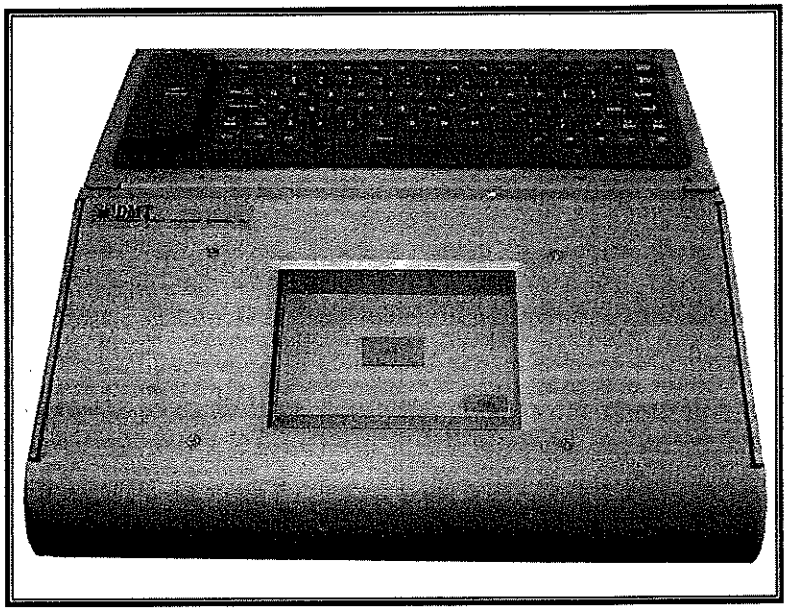
National Patent
Analytical Systems, Inc.



DMT Technical Guide

BAC Datamaster DMT Manual Overview

Welcome to the BAC DataMaster Transportable (DMT) Infrared Electronic Breath Alcohol Measuring Instrument. This technician's manual is designed to cover the maintenance and repair of the BAC DataMaster DMT with which the program technician should be familiar.



The information contained in this guide is generic for the DataMaster DMT (hereafter referred to as DMT). The software, internal hardware, test sequences and data entries may or may not be the same as that used by any particular law enforcement or other independent agency. For this information it is necessary to contact that particular agency as most law enforcement agencies print customized guides based on the software and hardware configurations chosen.

The DMT, like its predecessors: the Standard Datamaster, and the Datamaster cdm, operates on the scientifically accepted principal of absorption of infrared energy. This technology has been in use in the art of breath alcohol testing for over 30 years and is judicially accepted in every state in the union. The DataMaster has been in production since 1987 and is in use in, or approved by, over 30 states and many countries. The DMT shares the tested and proven core technology of the Datamaster, as well as including the evolving technologies of today to help equip our customers with the versatility they need in an ever changing society.

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Acceptance of these documents consisting of any and all schematics, descriptions, service bulletins, diagnostic routines, and trouble shooting guides and any other information enclosed in this manual relating to the BAC Datamaster DMT™ are trademarks of National Patent Analytical Systems, Inc.

License to use BAC DataMaster Software

The software resident in the BAC DataMaster DMT is and remains the exclusive property of National Patent Analytical Systems, Inc. (NPAS) having its principal place of business at 2090 Harrington Memorial Road Mansfield, OH 44903. By the purchase, acceptance, or use of this BAC DataMaster the purchaser, recipient and or user agrees to be bound by the terms of this license agreement.

NPAS provides analytical devices known in the marketplace as the "BAC DataMaster," "DataMaster," "DataMaster cdm," and "Datamaster DMT" with the intent that the instruments be used in the measurement of alcohol in the breath of human subjects. These devices incorporate software (the "NPAS" Software), which is highly confidential and proprietary information owned by NPAS. NPAS has established that it is the owner of copyrights, both registered and unregistered on all portions of this software. Both registered and unregistered software is protected by Federal Copyright Laws.

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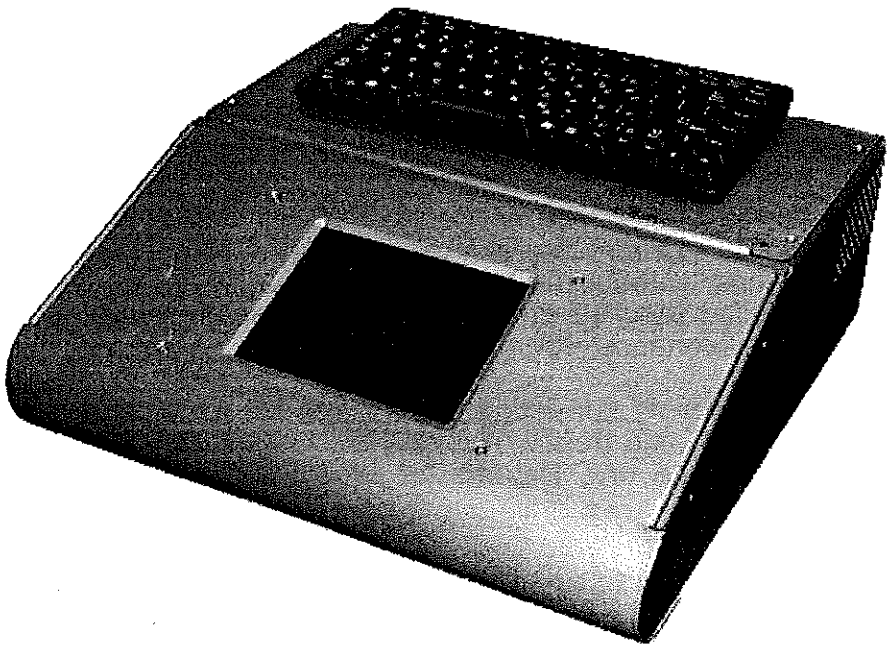
The recipient acknowledges that the obligations of this agreement, to maintain in confidence all information, are continuing, and remain effective even after the Confidential Information is returned to NPAS and the instrument is no longer used.

This agreement constitutes the entire agreement of the parties and is governed by the laws of the State of Ohio, without regard to its conflicts of laws provisions. In the event that suit is instituted to enforce any right hereunder, the prevailing party shall be entitled to recover from the other party its reasonable attorney's fees and cost of suit, including on any appeal.



Training Policies

Training is subject to state policies and procedures. We recognize and train at three levels of ability:

1. Operator
2. Supervisor
3. Technician

Operator – runs tests on individuals.

Supervisor – trains operators and other supervisors. This person is able to change sequences, dates, and times, as well as, run tests for purposes of checking and keeping records for purpose of maintenance.

Technician – has total ability to service, operate, and supervise others in the operation of the instrument.

Certification

On a state basis we will certify individuals as:

1. Operators
2. Supervisors
3. Technicians

This is based on the State and their policies, procedures, and regulations. In the private business sector we train individuals to the competency as discussed under "Training Policies." We feel that proper training and certification is extremely important in the overall operation of an alcohol breath test program.

Maintenance and Storage

The manufacturers of the Datamaster are of the opinion that the end user will use prudent judgment as to where to place and how to maintain our instrument. We believe that the frequency of maintenance is the responsibility of the user based on "as needed" rather than "as required."

A certified breath testing instrument and simulator shall be stored and maintained in such a manner as to be free from dust, moisture, substances, or forces that may affect its accurate operation.

The Technology of the DMT: an Overview

The DataMaster operates on the scientifically accepted principle of absorption of infrared energy. This technology has been in use in the art of breath alcohol testing for over 25 years and is judicially accepted in every state in the union. The analytical portion of the DMT is essentially identical to the analytical portion of BAC DataMaster and DataMaster cdm. That is where the similarity between the instruments ends.

Below is a list, and brief description of the new technology utilized in the DMT:

- The user interface is based on a Windows CE.NET® embedded PC. The incorporation of Windows CE allows for development of a graphical user environment which makes viewing past and present test data easier. Subject tests can be viewed in real time as the test is performed; graphing both the breath flow and the alcohol level simultaneously. *Note: Although the graphical interface is based on Windows, it is created by National Patent Analytical Systems Inc. and is considered proprietary.*

- Integration of USB technology, allowing for greatly increased versatility. Four ports are currently supplied.

- A touch screen, available in two sizes, is also utilized for further ease of use.

- Internal printers are no longer used, as the Windows platform allows for simple integration of common printer driver software and USB port interconnections. *Note: The version of Windows used in the DMT is CE.NET. This means that full Windows is not used and that full printer driver functionality is not available. Printers will function as expected, once the correct driver software is selected, however, full communications like paper empty messages will not be displayed. This is a limitation of Windows CE.NET rather than a limitation of the DMT.*

- Surface Mount technology on the main controller circuit board. This saves space, and reduces overall power dissipation, which in turn makes the unit run more efficiently.

- Mass airflow sensor. This is utilized in the DMT to measure a subject's breath ensuring higher accuracy and control when calculating total test volume and enables the ability to graph the flow in real time.

- Digitally controlled potentiometers for voltage settings. This allows for increased versatility and control from the software, and in most cases, eliminates the need to use external meters to check the instrument's voltages or even opening the instrument at all to perform those checks.

- Availability of running on either standard line voltage, 12Vdc as found in automobiles, or even from an external 12Vdc battery.

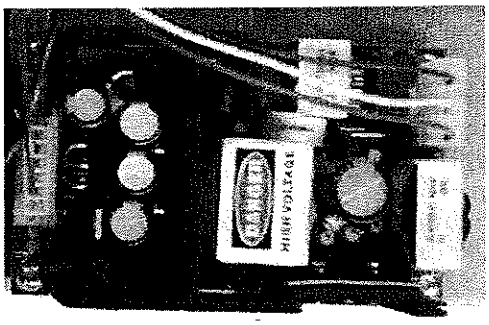
Basic Circuit Analysis of the DMT

The Datamaster DMT was designed to increase the versatility of the highest quality alcohol breath testing instrument in the world. The first step in this was to design a new system running totally off of a 12 volt dc input voltage and this section will discuss how the circuitry works in the DMT thus enabling that goal.
Currently, the Transportable Datamaster has five main electronic components consisting of three off the shelf products, and two products designed exclusively by and for National Patent.

**Note: The information given in this section is to aid the technician in understanding the electronics of the DMT, with the intention that it will better aid in troubleshooting the instrument when there is a problem. It is understood and accepted that if the instrument is operating properly and without error messages the following circuits are also operating properly.*

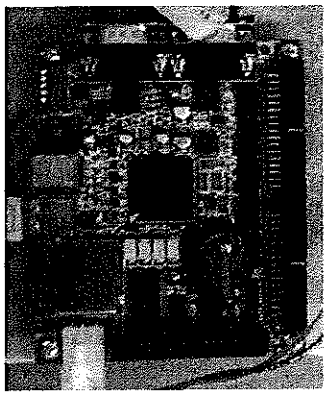
The Power Supply

The power supply is an off the shelf unit providing an output of 12Vdc at 120 watts peak power. This unit is capable of taking 120 Volts ac line voltage and converting it down to the required level.
When using an external power source, like a properly rated battery, or a car cigarette lighter with the proper cord, the internal power supply is bypassed.



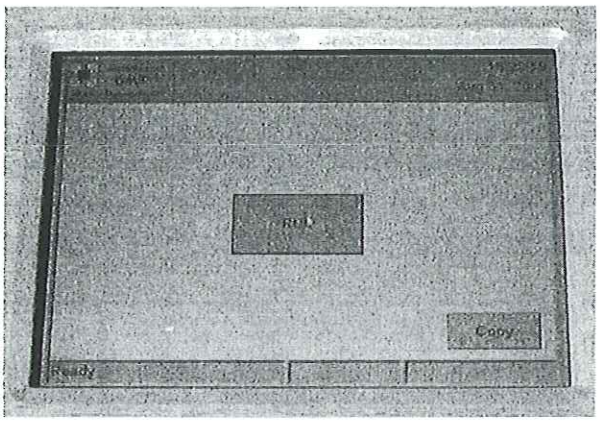
The Embedded PC

This is an off-the-shelf product. Essentially, it is a mini-computer used to interface the DMT controller board, the display, and other optional components like inkjet printers, based off of the Windows CE.NET operating system.



Touch Screen Display

The display is purchased off-the-shelf and currently available in either 6.2" or 8.2" sizes. It directly connects to the mini processor and can be used as the user interface panel, eliminating the need for a separate keypad.

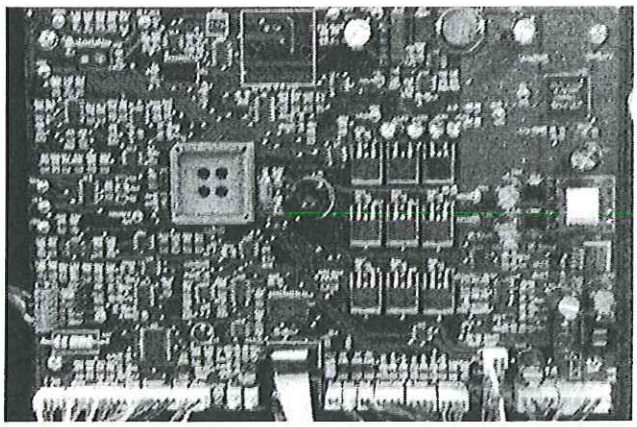


USB Hub Extension and Modem Interface PCB

This board is designed by National Patent to expand the USB capabilities of the processor, extend the ports to the back of the instrument for easier access, and interface with the modem IC. Currently, there are four USB ports available for customer use.

DMT Controller Board

The Controller Board is the end result of extensive engineering to bring all of the original Datamaster circuit boards into one card. It contains all of the analysis, diagnostic, and control circuitry for the DMT.



Note: The next sections go into more detail regarding the various control circuitry involved in operating the DataMaster DMT located on the Controller Board. Functional Diagrams are used for illustration purposes to aid the discussion on each portion of the board.
For ease of reference, the following sections regarding the Controller Board are discussed in the order they appear in, and titled as labeled per the schematics for the instrument as produced by the National Patent Engineering Department.

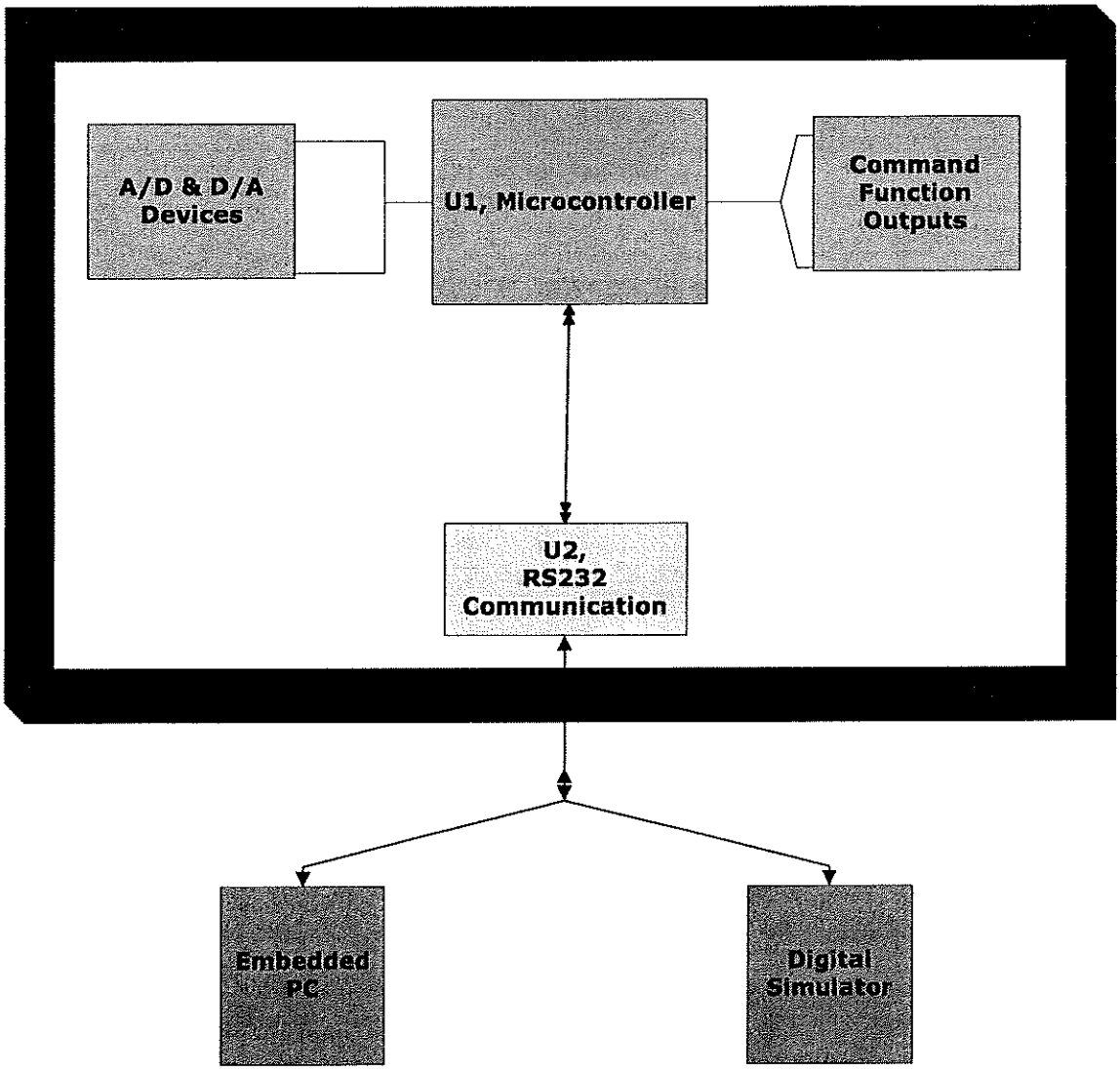
DMT Controller Board

All of the control protocols are stored in U1, which is a PIC17C752; a programmable microcontroller that runs off of a 19.6Mhz clock speed. This microcontroller maintains the base level Datamaster functions and works in conjunction with the A/D & D/A devices to monitor & control the instrument.

The PIC communicates with the mini computer by way of U2, which is an RS232 transmission and receiver IC. This IC allows for two way communication on two ports; one port is used for the mini-computer, the other is used for receiving simulator temperature readings when hooked up to an appropriately equipped simulator.

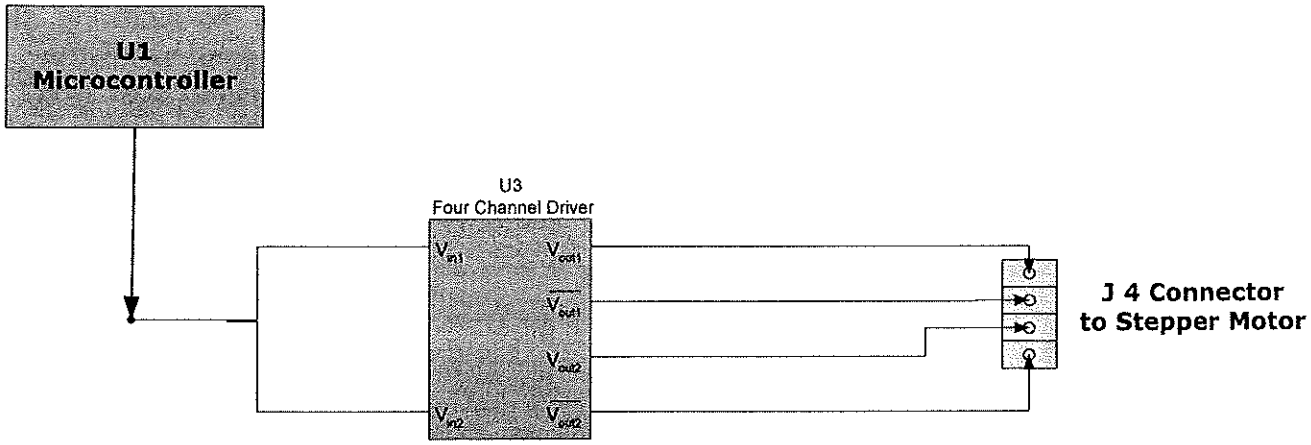
The A1 beeper is used for any necessary alarms during the course of operation.

The connector J4 is the direct connection to the infrared detector mounted on the filter wheel block in the optical path.

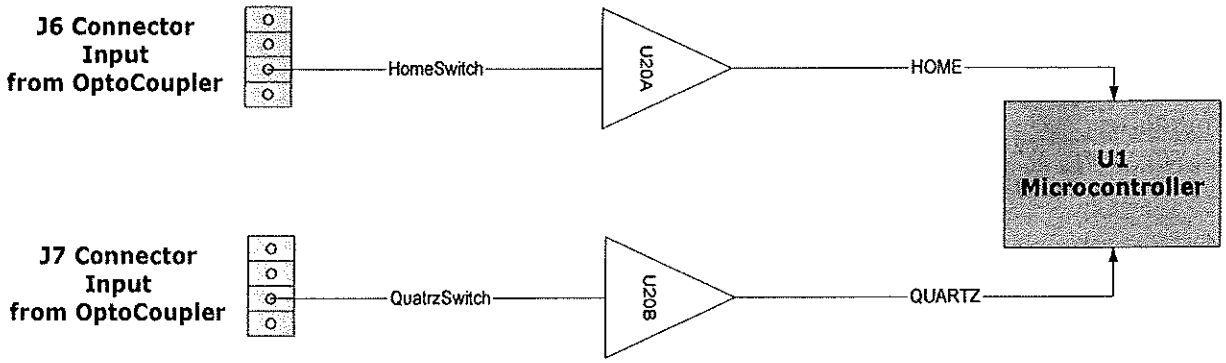


Chopper & Stepper Control

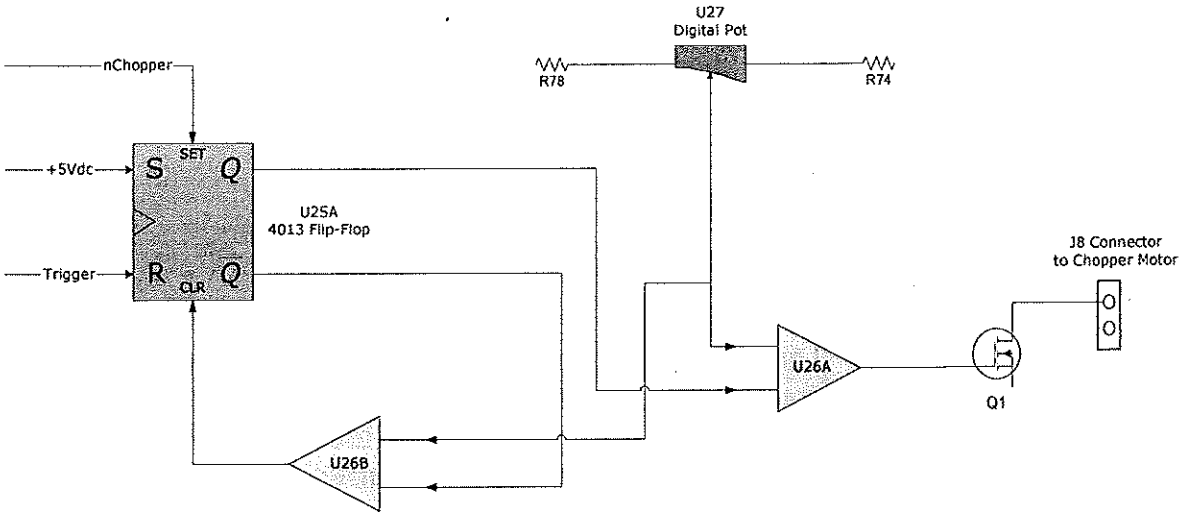
U3 is a L293DD, a monolithic integrated high voltage, high current four channel driver designed to accept standard DTL or TTL logic levels and drive inductive loads (such as relays, solenoids, and stepping motors) and switching power transistors. This device is used as the interface between U1 and the stepper motor to control the Filter Wheel movement.



The Filter & Quartz wheel movement is monitored by opto-sensors mounted on the Filter Block and connected at J6 & J7, respectively to the board. On the schematics the "HomeSwitch" & "QuartzSwitch" signals are reported as an "on or off" voltage which is fed into a precision voltage comparator, an LM293, located at U20 A & B, respectively. These signals are then transmitted to U1 as "Home" & "Quartz." U1 uses these signals to determine what position the filter wheels are in.

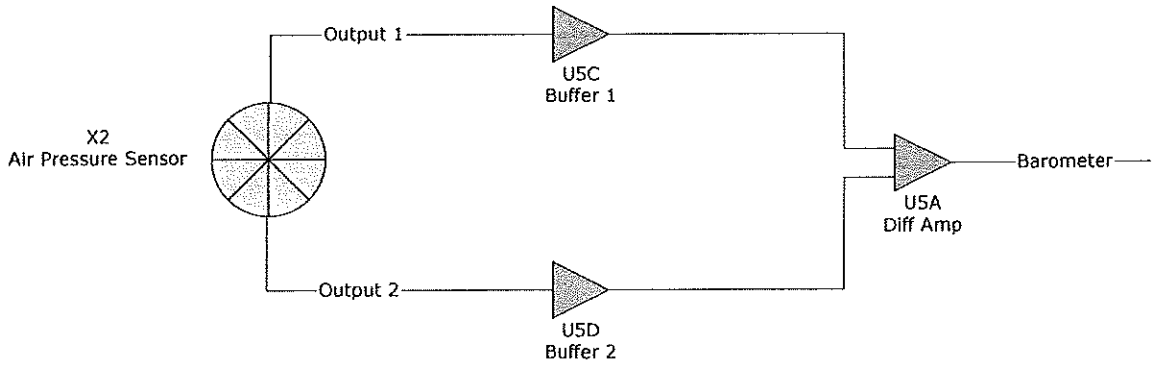


Chopper control is initialized by a signal from U1, "nChopper," to U25A, which is a D-type flip-flop. Once started the Trigger signal produced by the Detector Signal processor begins to force set and reset states. This IC together with U26B, an LM358, creates a frequency to voltage converter producing pulses at a fixed duration and independent of frequency. The voltage produced at pin 1 of U25A is a dc level and proportionate to frequency. The frequency itself is established by the voltage divider of R74 & R78, with varying control added by U27, which is a digital potentiometer. U27 allows for control of the chopper motor speed and is set through software control via the tech screen. U26A sends an "on or off" type signal to the MOSFET, Q1, which in turn activates the chopper motor.

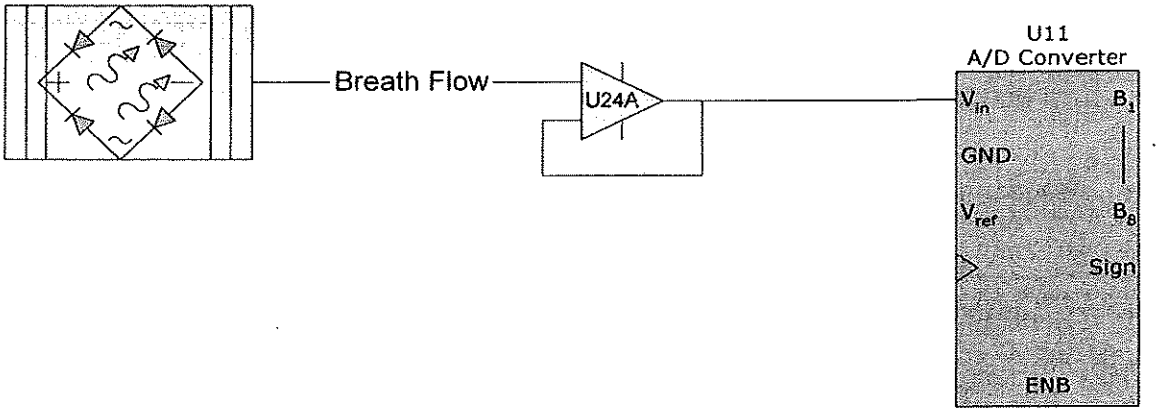


Breath Flow Rate & Barometric Pressure

X2 is an SCX15AN type air pressure sensor. These internally calibrated and temperature compensated sensors were specifically designed to provide an accurate and stable output over a 0°C to 70°C temperature range. The output from pins 3 & 5 are fed through U5C & D, respectively, which are then fed to U5A a differential amplifier. Differential amplifiers increase the difference between two input signals, and are used in instrumentation to measure small variances in critical applications.

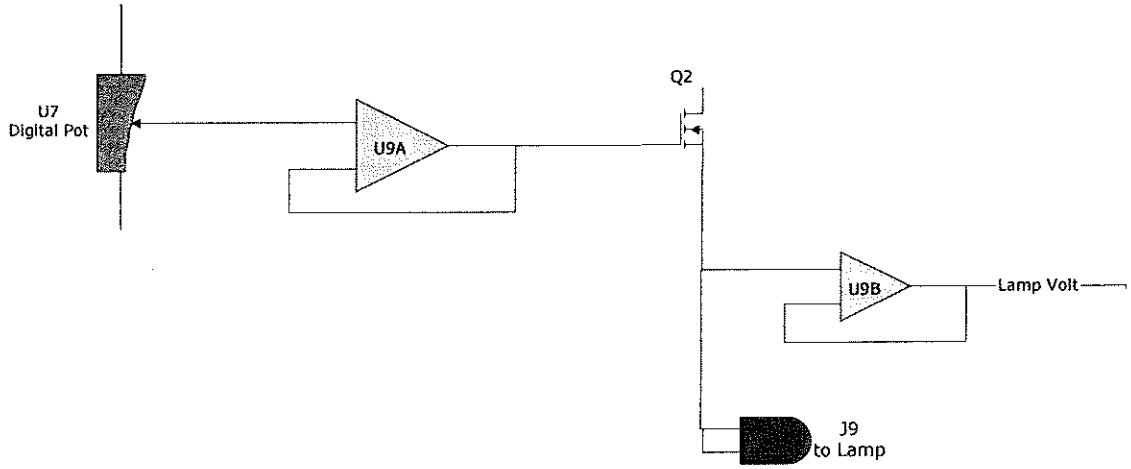


U6 is an AWM3300V type mass air flow sensor. Mass Airflow sensors contain a thin-film, thermally isolated bridge structure that contains both heater and temperature sensing elements. The bridge structure provides a sensitive and fast response to changes in airflow or other gasses over the chip. The output of U6 is fed to U24a, a voltage follower type amplifier to stabilize the signal, then forwarded on to U11 an A to D converter which then provides the output to U1.



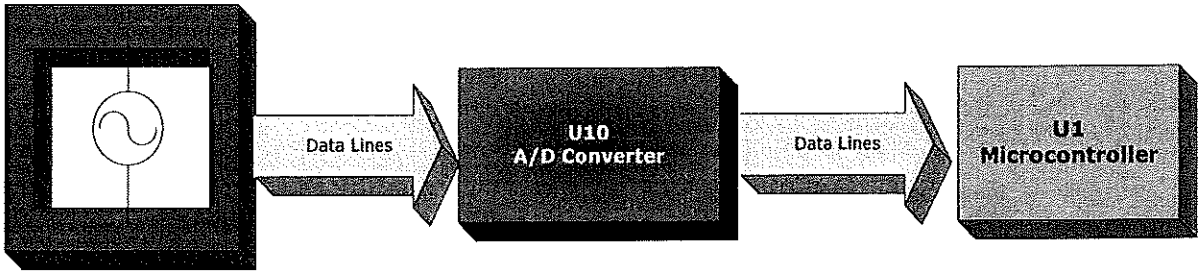
Lamp Supply

The infrared source (Lamp) is controlled by a digital potentiometer, U7, and is set through software via the user interface on the Tech Screen. The set voltage is fed through U9A to Q2. Q2 is an FET mounted on the five-way valve. The digital potentiometer in conjunction with the op amp sets current through the pass transistor, and the lamp. The amp provides a constant reference voltage across the digital pot. By operating in its linear region, the transistor controls load current in response to the applied gate voltage. Each incremental step of the digital pot increases or decreases the voltage VIN+ at the op amp's non-inverting input. Thus, the pot's wiper voltage (VIN+) varies with respect to the reference voltage, which in turn remains stable with respect to the +5V supply.

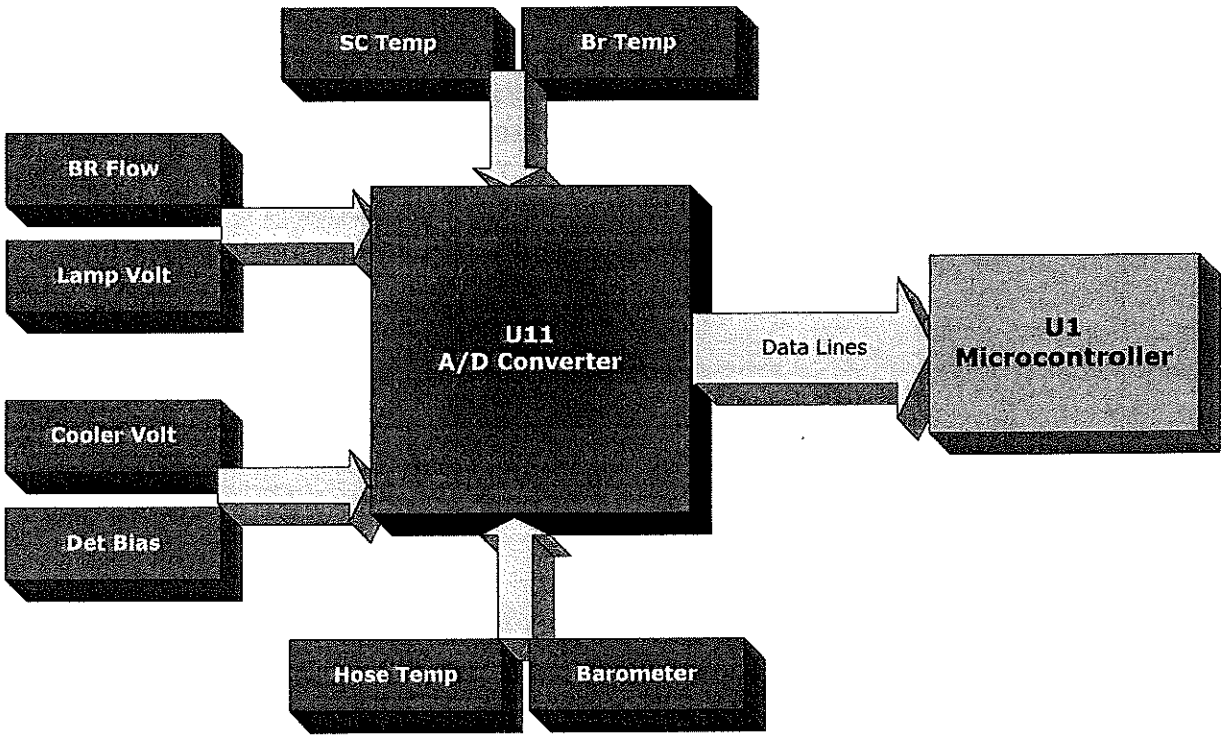


A/D and D/A Stuff

U10 is an AD977, which is a high speed low power A to D converter dedicated to monitoring and converting the detector signal, labeled as DET SIG on the schematics. It then forwards the data to U1.

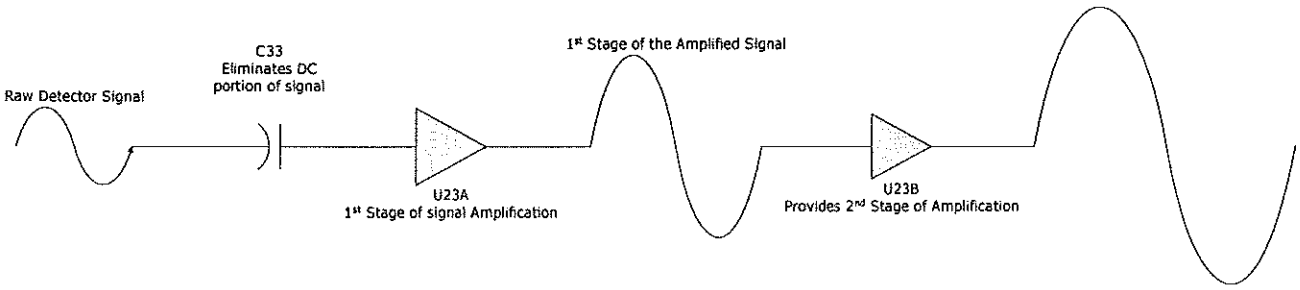


U11 is a TLC2453, another high speed, low power A to D Converter. This device takes the signals from the breath flow, cooler voltage, lamp voltage, Sample Chamber temperature, breath tube temperature, simulator tube temperature, and barometer circuits; converts them to data, and then sends them to U1.

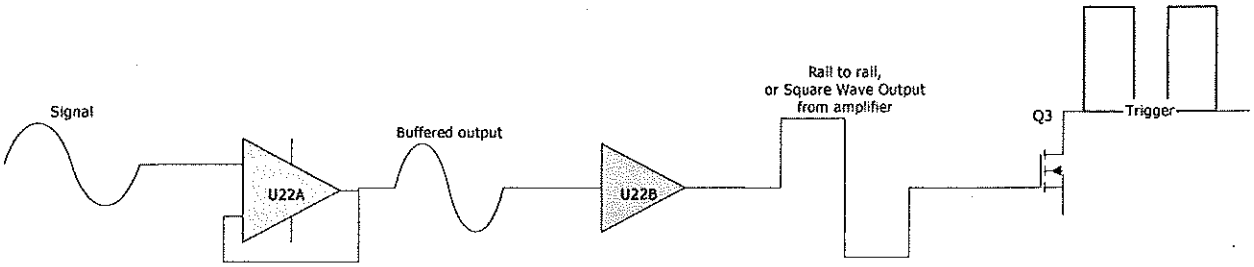


Detector Signal Processor

The chopped, raw detector signal is received from pin 2 of J24, and coupled to pin 3 of U23, U23A, an LF 353 op-amp via the capacitor at C33. The capacitor removes the 120Vdc bias voltage so only the sinusoidal wave form remains. U23A amplifies the signal by approximately of eleven before passing it through another band pass circuit. Pin 5 of U23, U23B is the input of the second stage of gain that amplifies the circuit by a factor approximately equaling eleven.

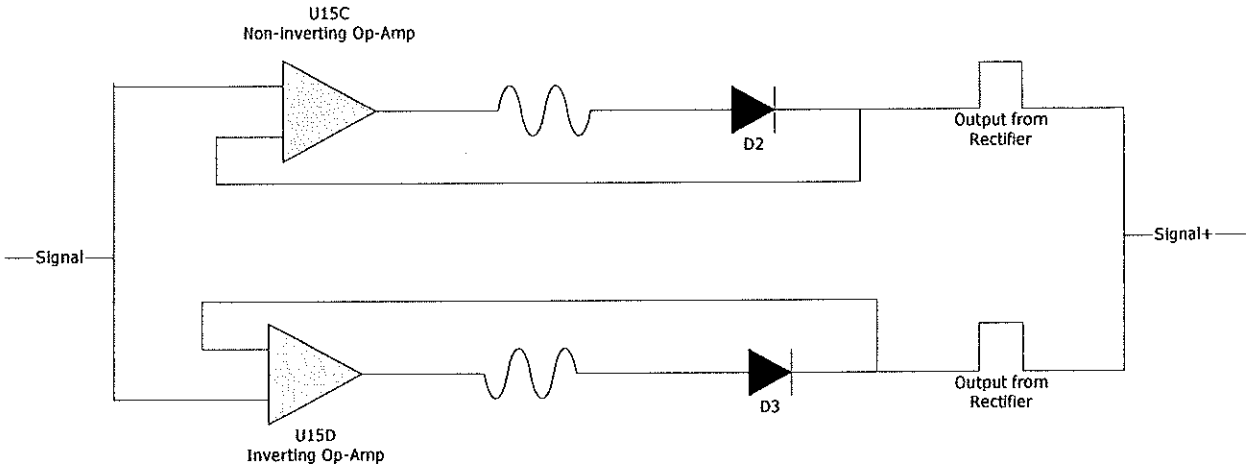


The schematics reference the output of U23B as "SIGNAL." This is so a technician can follow the fact that this references two separate sections of the processor circuit. One portion is fed into the rectifier portion of the circuit, which will be discussed in a moment. The other section is where the "Trigger" signal is created for the chopper circuit control. The signal is fed into pin 3 of U22A. U22B is set with max gain, so that when the signal is input to pin 6 from U22A, the output of U22B runs between the voltage supply rails of +5Vdc, and -5Vdc based on the frequency of the detector signal. This output is fed through a current limiting resistor to Q3, a MOSFET, which is only active on the positive going side of the cycle. This produces a 0 to +5Vdc signal and becomes the "Trigger" signal that is input into the Chopper Control circuit.



The other section that receives the "SIGNAL" is the rectifier portion of the processor circuit. U15C and D2 combine to form a non-inverting precision half-wave rectifier. A precision rectifier actually is, in its simplest form, an op-amp that includes a diode in the feedback loop. This effectively cancels the forward voltage drop of the diode, so very low level signals (well below the diode's forward voltage) can still be rectified with minimal error. For a low frequency positive input signal, 100% negative feedback is applied when the diode conducts. The forward voltage is effectively removed by the

feedback, and the inverting input follows the positive half of the input signal almost perfectly. When the input signal becomes negative, the op-amp has no feedback at all, so the output pin of the op-amp swings negative as far as it can. When the input signal becomes positive again, the op-amp's output voltage will take a finite time to swing back to zero, then to forward bias the diode and produce an output. This time is determined by the op-amp's response time, or slew rate as it is actually referred to.
The same idea is applied U15D and D3, with the exception that the input is fed to the inverting side of the op-amp. The effective output is a rectified dc with a small amount of ac ripple riding on the signal. The output is labeled as SIGNAL+ on the schematics for easy reference.



SIGNAL+ is fed to U15B for buffering and conditioning then goes through an RC circuit to remove any ac signal from the rectified output. U16C adds further conditioning to the signal before sending it to U12, a D/A converter, which establishes a DA REF signal, and U16D, which is a summing amplifier. A Summing amplifier is an op-amp circuit whose output is proportional to the sum of its instantaneous voltages. This type of amplifier is used for combining several signals. The most common use of a summing amplifier with two inputs is the amplification of a signal combined with the subtraction of a constant amount from it (dc offset). In this case, the constant amount that is subtracted out of the signal is input at pin 12 of U16D.

The output from U16D is fed through U16A and U16B for additional control and buffering. The output from U16B then becomes the "DET SIG" that is processed by U11, an A/D converter.

Cooler Control

Detector Bias Supply

The MAX1771 step-up switching controller provides 90% efficiency over a 30mA to 2A load. A unique current-limited pulse-frequency-modulation (PFM) control scheme gives this device the benefits of pulse-widthmodulation (PWM) converters (high efficiency at heavy loads), while using less than 110µA of supply current (vs. 2mA to 10mA for PWM converters).

Heaters and Switches

DMT RF Detector

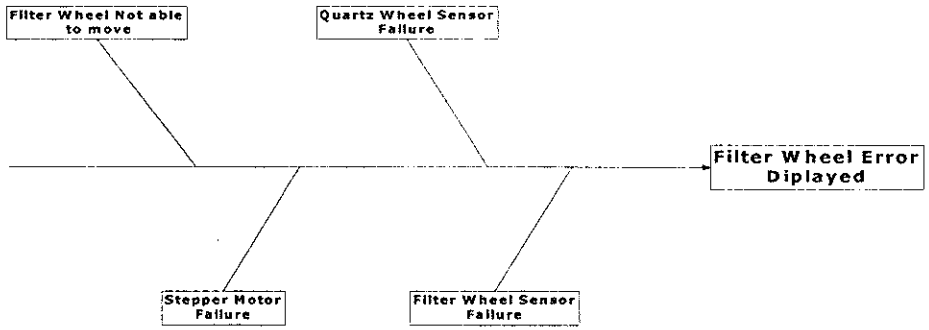
Filter Wheel Error

Condition that causes the error code:

The DMT is unable to detect movement from the Filter Wheel.
The DMT is designed with optical sensors which report the movement of the Filter & Quartz Wheel. Positioning is established at the beginning of a sequence of tests (diagnostic, breath, simulator checks), or when entering the TECH SCREEN, which is then saved in memory until the test is complete or the tech screen closed. Once established for the test, the software and sensors work in conjunction to ensure the filter wheels are functioning properly.

Possible Causes of the Error:

- The wheel is unable to physically move.
- The Quartz wheel sensor failed.
- The Filter wheel sensor failed.
- The stepper motor failed.



Possible Items to check for Solution:

- Physically check both the filter and quartz wheels for anything that might be blocking movement. The wheels are geared and assembled to move in conjunction with each other.
- Voltage failure to the stepper motor or sensors.
- Alignment of the motor or sensors is out.

Ambient Fail

Condition that causes the error code:

The DMT detects a shift in the detector voltage greater than 30mVdc from the established zero during the Ambient Testing phase of an analysis.

Possible Causes of the Error:

- Ambient air is contaminated with substance detectable by the DMT (ie rubbing alcohol, paint fumes, etc)
- Debris in the sample chamber that moves erratically when the pump is active, causing random shifts in the expected infrared levels seen by the detector.
- Detector voltage is unstable

Possible Items to check for Solution:

Internal Standard Error

Condition that causes the error code:

Possible Causes of the Error:

Possible Items to check for Solution:

Detector Overflow

Condition that causes the error code:

Possible Causes of the Error:

Possible Items to check for Solution:

Standard Acquisition

Condition that causes the error code:

Possible Causes of the Error:

Possible Items to check for Solution:

Breath Tube not to Temperature

Condition that causes the error code:

Possible Causes of the Error:

Possible Items to check for Solution:

Simulator Tubes not to Temperature

Condition that causes the error code:

Possible Causes of the Error:

Possible Items to check for Solution:

Radio Interference Detected

Condition that causes the error code:

Possible Causes of the Error:

Possible Items to check for Solution:

Pump Error

Condition that causes the error code:

Possible Causes of the Error:

Possible Items to check for Solution:

User Abort

Condition that causes the error code:

Possible Causes of the Error:

Possible Items to check for Solution:

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